CLAIMS

1. A method for recovering an image defined as a function of image coordinates of an image space from compressed data that is a function of transform coordinates in a transform space comprising:

a) transforming said compressed data using at least one partial transform that transforms at least one but not all of the transform coordinates into a corresponding image coordinate to generate a set of intermediate coefficients which are functions of at least one coordinate from the image space and at least one coordinate from the transform space in a space intermediate between said transform space and said image space said intermediate space being defined by at least one coordinate from the image space and at least one coordinate from the transform space;

b) adjusting the value of at least one intermediate coefficient and using said adjusted value to generate a set of adjusted intermediate coefficients; and

c) recovering said image by transforming said set of adjusted intermediate coefficients to said image space with at least one additional partial transform.

2. A method according to claim 1 wherein adjusting the value of at least one partial coefficient comprises:

a) determining an adjustment range;

b) determining a value in said adjustment range; and

c) setting the value of said intermediate coefficient equal to said determined value.

3. A method according to claim 2 wherein said compressed data comprises information for determining a set of quantized values and a quantizer for each quantized value as functions of coordinates of said transform space, and wherein transforming said data comprises determining a first set of coefficients in said transform space using said quantizers and said quantized values and transforming said first set of coefficients with said at least one partial transform.

4. A method according to claim 3 wherein determining said first set of coefficients comprises determining the product of each quantized value with its quantizer and determining said first set of coefficients as a set comprising all said products.

5. A method according to claim 3 wherein determining said first set of coefficients comprises determining the product of each quantized value with its quantizer, adjusting the value of at least one of said products and determining said first set of coefficients as a set comprising all said products.

6. A method according to any of claims 3-5 wherein determining an adjustment range comprises determining at least one adjustment limit and determining said adjustment range responsive to said adjustment limit.

7. A method according to claim 6 wherein determining at least one adjustment limit comprises transforming said set of quantizers with said at least one transform to generate a set of transformed quantizers in said intermediate space and determining an adjustment limit for at least one intermediate coefficient responsive to at least one transformed quantizer of said set of transformed quantizers.

8. A method according to claim 7 comprising adjusting the value of at least one quantizer responsive to values of said first coefficients prior to transforming said set of quantizers.

9. A method according to claim 8 wherein adjusting the value of at least one quantizer comprises determining whether all of said first set of coefficients are zero for a value of a single coordinate of said transform space greater than a certain value and constant values for all other transform space coordinates and if so, setting the values of the quantizers corresponding to said zero coefficients equal to a same value.

10. A method according to claim 9 wherein said same value is equal to the maximum of said coefficients for all values of said single coordinate and said constant values for all other coordinates.

11. A method according to any of claims 7 - 10 wherein said at least one adjustment limit for said at least one intermediate coefficient is determined responsive to the transformed quantizer having the same coordinates in the intermediate space as the at least one intermediate coefficient.

12. A method according to claim 11 wherein said adjustment limit is equal to said corresponding transformed quantizer multiplied by a fraction less than one.

13. A method according to claim 12 wherein said fraction is equal to 0.5.

14. A method according to claim 6 wherein determining at least one adjustment limit comprises determining an adjustment limit for at least one intermediate coefficient responsive to the value of at least one of said intermediate coefficients.

15. A method according to claim 14 wherein determining said at least one adjustment limit comprises determining the difference between a maximum and minimum intermediate coefficient in a plurality of intermediate coefficients in said set of intermediate coefficients and determining said adjustment limit responsive to said difference.

16. A method according to claim 15 wherein said plurality of intermediate coefficients comprises intermediate coefficients in a neighborhood of said at least one intermediate coefficient.

17. A method according to claim 15 wherein all but one of the coordinates of any two of the plurality of intermediate coefficients are the same and wherein the plurality of intermediate coefficients includes the at least one intermediate coefficient.

18. A method according to any of claims 15 – 17 wherein said adjustment limit is equal to said difference multiplied by a fraction less than one.

19. A method according to claim 16 wherein said fraction is equal to 0.5.

20. A method according to any of claims 3 - 19 comprising testing said set of adjusted intermediate coefficients for consistency with said first set of coefficients in said transform space.

21. A method according to claim 20 wherein testing said set of adjusted intermediate coefficients comprises transforming said set of adjusted intermediate coefficients into a second

set of coefficients in said transform space and comparing coefficients of said first set with coefficients of said second set to determine if said set of adjusted coefficients is consistent with said first set of coefficients.

22. A method according to claim 21 wherein comparing coefficients comprises determining how close the value of at least one coefficient of said first set is to the value of at least one coefficient of said second set.

23. A method according to claim 22 wherein determining how close the value of at least one coefficient of said first set is to the value of at least one coefficient of said second set comprises using a metric.

24. A method according to any of claims 20 - 23 wherein, if said set of intermediate coefficients is not consistent with said first set of coefficients, the value at least one adjusted intermediate coefficient of said set of adjusted intermediate coefficients is readjusted to generate a readjusted set of intermediate coefficients so that said set of readjusted intermediate coefficients is consistent with said first set of coefficients.

25. A method according to any of the preceding claims wherein adjusting said at least one intermediate coefficient comprises adjusting said at least one intermediate coefficient responsive to coefficients in a neighborhood of said at least one intermediate coefficient.

26. A method according to claim 25 wherein said neighborhood comprises a plurality of intermediate coefficients, including said at least one intermediate coefficient, for which any two intermediate coefficients have same values for all the same coordinates except one.

27. A method according to any of the preceding claims wherein adjusting said at least one intermediate coefficient comprises adjusting said at least one intermediate coefficient responsive to a ratio between a partial coefficient and a function of other partial coefficients.

28. A method according to any of the preceding claims wherein adjusting said at least one intermediate coefficient comprises adjusting said at least one partial coefficient responsive to a

trend in changes of values of partial coefficients as a function of changes in at least one coordinate of said intermediate space.

29. A method according to any of the preceding claims wherein adjusting said at least one intermediate coefficient comprises adjusting said at least one partial coefficient responsive to an expected trend in changes of values of partial coefficients as a function of changes in at least one coordinate of said intermediate space.

30. A method according to any of the preceding claims wherein adjusting said at least one intermediate coefficient comprises adjusting said at least one partial coefficient responsive to a predetermined template.

31. A method according to claim 30 wherein said template identifies an edge in said recovered image and comprising smoothing said recovered image on either side of said identified edge.

32. A method according to any of the preceding claims wherein adjusting the value of said at least one intermediate coefficient comprises adjusting the value of said at least one intermediate coefficient responsive to data from different compressed data that is related to said compressed data.

33. A method according to claim 32 wherein said image in said image space comprises values for a first color component of a color image in said image space and said different compressed data comprises data for generating a second color component image of said color image.

34. A method according to claim 32 or claim 33 wherein said different compressed data identify an edge in said recovered image.

35. A method according to claim 31 or claim 34 comprising smoothing said image on either side of said edge.

36. A method according to any of the previous claims comprising testing said set of adjusted intermediate coefficients for consistency with a first set of intermediate coefficients defined in an intermediate space different from said intermediate space in which said adjusted intermediate coefficients are defined.

37. A method according to claim 36 wherein testing said set of adjusted intermediate coefficients comprises transforming said set of adjusted intermediate coefficients into a second set of intermediate coefficients in said different intermediate space and comparing intermediate coefficients of said first set with intermediate coefficients of said second set to determine if said set of adjusted coefficients is consistent with said first set of intermediate coefficients.

38. A method according to claim 37 wherein comparing coefficients comprises determining how close the value of at least one intermediate coefficient of said first set is to the value of at least one intermediate coefficient of said second set.

39. A method according to claim 38 wherein determining how close the value of at least one intermediate coefficient of said first set is to the value of at least one intermediate coefficient of said second set comprises using a metric.

40. A method according to any of claims 36 – 39 wherein if said set of adjusted intermediate coefficients is not consistent with said first set of intermediate coefficients, the value at least one adjusted intermediate coefficient of said set of adjusted intermediate coefficients is readjusted to generate a readjusted set of intermediate coefficients so that said set of readjusted intermediate coefficients is consistent with said first set of intermediate coefficients.

41. A method for recovering an image defined as a function of image coordinates in an image space from compressed data that is a function of transform coordinates in a transform space the method comprising:

a) using said data to generate a first set of recovered transform coefficients in said transform space;

b) determining an adjustment range for at least one recovered transform coefficient;

c) replacing said at least one recovered transform coefficient by a value in said adjustment range responsive to recovered transform coefficients in a neighborhood comprising less than all of said recovered transform coefficients of said at least one recovered transform coefficient, to generate an adjusted set of recovered transform coefficients; and

d) recovering said image by transforming said adjusted set of recovered transform coefficients to said image space.

42. A method according to claim 41 wherein said neighborhood comprises a plurality of recovered transform coefficients including said at least one recovered coefficient, for which any two recovered coefficients have same values for all the same coordinates except one.

43. A method for recovering an image defined in an image space from compressed data that comprises quantized values and a quantizer for each quantized value that are functions of transform coordinates in a transform space the method comprising:

a) determining a set of recovered transform coefficients in which each recovered transform coefficient is a product of a quantized value with its quantizer;

b) determining an adjustment range having an upper and lower limit for at least one recovered transform coefficient of said first set of recovered coefficients, wherein the difference between said upper and lower limit is less than the magnitude of said quantizer used to determine said at least one recovered coefficient ;

c) replacing said at least one recovered transform coefficient by a value in said adjustment range to generate an adjusted set of recovered transform coefficients; and

d) recovering said image by transforming said adjusted set of recovered transform coefficients to said image space.

44. A method for recovering an image defined in an image space from a first set of compressed data that comprises quantized values and a quantizer for each quantized value that are functions of transform coordinates in a transform space the method comprising:

a) determining a first set of recovered transform coefficients in which each recovered transform coefficient is a product of a quantized value with its quantizer;

b) determining an adjustment range for at least one recovered coefficient;

c) replacing said at least one transform coefficient with a value in said adjustment range responsive to recovered transform coefficients generated using a second set of related compressed data to generate an adjusted set of recovered transform coefficients; and

d) recovering said image by transforming said adjusted set of recovered transform coefficients to said image space.

45. A method according to claim 44 wherein said first and second sets of compressed data are generated from different color component images of a color image.

46. A method for adjusting an image having a plurality of image values defined in an image space, said image values being generated from compressed data comprising quantized values and a quantizer for each quantized value that are functions of transform coordinates in a transform space the method comprising:

determining an adjustment range for at least one image value of said plurality of image values responsive to an average of a plurality said quantizers;

determining a value in said adjustment range;

adjusting said image by replacing said at least one image value with said determined value.

47 A method for adjusting an image according to claim 46 wherein determining an adjustment range comprises determining an adjustment range responsive to a fraction less than one of the average quantizer.

48. A method for adjusting an image having a plurality of image values defined in an image space, said image values being generated from compressed data comprising quantized values and a quantizer for each quantized value that are functions of transform coordinates in a transform space the method comprising:

determining an adjustment range for at least one image value of said plurality of image values responsive to a maximum or a minimum quantizer of a plurality of said quantizers;

determining a value in said adjustment range;

adjusting said image by replacing said at least one image value with said determined value.

49. A method for adjusting an image according to claim 48 wherein determining an adjustment range comprises determining an adjustment range responsive to a fraction less than one of the maximum or minimum quantizer.

50. A method according to any of claims 46 - 49 wherein said plurality of said quantizers comprises all quantizers in said compressed data.

51. A method according to any of claims 46 – 50 wherein determining a value comprises determining a value responsive to image values of a different related image.

52. A method according to claim 51 wherein said image and said different related image are color component images of a multicolor color image.

53. A method according to any of the preceding claims comprising smoothing said recovered image.

54. A method according to any of the preceding claims wherein said image is an image defined in a three dimensional image space.

55. A method according to any of the preceding claims wherein said image is an image defined in a two dimensional space.

56. A method according to any of the preceding claims wherein said compressed data is data generated using a unitary separable transform to transform an image in said image space into a set of values in said transform space.

57. A method according to any of the preceding claims wherein said compressed data is generated using a JPEG compression method.

58. A method according to any of claims 1- 56 wherein said compressed data is generated using an MPEG compression method.

59 A method according to any of claims 1- 56 wherein said compressed data is generated using a PX64 compression method.

60. A method according to any of claims 1- 56 wherein said compressed data is generated using an H261 compression method.

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61. A method according to any of claims 1- 56 wherein said compressed data is generated using an H263 compression method.

62. A method according to any of claims 1- 56 wherein said compressed data is generated using an H323 compression method.

63. A method according to any of claims 1- 56 wherein said compressed data is generated using an HDTV compression method.

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